Final Report

The Viability and Feasibility of Energy Cooperation in the SAARC Region

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Sanjay Gupta
New Delhi

Terms of Reference

1. The future demand for energy in countries of the region. based on scenarios of growth to be developed consistent with the potential of the region.

2. Assessment of the indigenous energy supply potential within the countries of the region by source of energy.

3. Extent of surplus energy available for cooperation in the field of hydrocarbons, with investigation of securities concerns, economic viability and technical feasibility.

4. Political initiatives, financing options, policy changes and institutional measures required to promote energy cooperation between SAARC countries.

5. Define the net potential economic benefit through technology and skill exchange within the SAARC, compared to obtaining such knowledge and services from companies in the 'North' countries.

6. Assess the potential training & education, and employment opportunities arising out of such cooperation.

1. Introduction

Aware of the common problems, interests and aspirations of the people of South Asia and feeling the need for joint action, the Heads of State or Government of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka signed the Charter of South Asian Association for Regional Cooperation at Dhaka on 8 December, 1995. Though not much tangible progress has taken place in economic and social cooperation, more importantly, this has resulted in an increased level of consciousness of the possibilities of cooperation for mutual gains. We have before us excellent examples various trade blocs such as the European Economic Community (EEC), the Caribbean Community (CARICOM), the Central American Common Market (CACM), the North American Free Trade Agreement (NAFTA) and closer to home, the ASEAN Free Trade Area (AFTA), where cooperation in the area of energy has contributed very significantly towards their formation.

Listed in Article I of the above mentioned Charter are the objectives of SAARC, two of which provide a rationale for this study:-

- to promote and strengthen collective self-reliance among the countries of South Asia.
- to promote active collaboration and mutual assistance in the economic, social, cultural, technical and scientific fields.

These concepts of mutual cooperation have received a strong boost by the decision at the recent SAARC summit in Male, Maldives to bring South Asian Free Trade Area (SAFTA) into force by the year AD 2001. This would result in greater economic efficiency and reduced dependence on countries of the "North" for technological inputs.

The SAARC nations share some common traits such as poor and rapidly growing populations; vast disparities in incomes and lifestyles; significant rural populations spread over extensive areas; high dependence on biomass fuels, especially among the rural populations; and very low, but exponentially growing, levels of per capita energy consumption. Thus, a strong case is made out for coordinated actions to meet the challenges in the energy sector in the region. This imperative arises from the fact that a large part of the hydro electric potential in the region can be tapped only if an integrated future of markets is to be taken cutting across national boundaries. Similarly, SAARC region is essentially dependent on imports of hydrocarbons. Yet, it lies in the vicinity of countries with rich natural gas resources. Given the economic attraction of pipeline transportation of natural gas, this becomes the most preferred means for import of natural gas into the region from the neighbouring countries. However, the pipeline to be established for this purpose would require transit through more than one nation and in order to achieve economies of scale, sharing of gas supplies among the countries of the region. There are significant structural similarities among the economies of this region and therefore, even in terms of sharing of experiences and finding solutions to these problems, a coordinated approach would have mutual benefits to all the parties concerned.

The development of the energy sector in the SAARC region would require substantial inflows of private capital, and since traditionally energy investments have been made by governments and the public sector, a major restructuring of the energy systems and decision making

mechanisms would be essential if South Asia were to become an attractive destination for investments, particularly from overseas. The process of liberalisation and economic reforms being pursued by several countries of the region provides great scope for sharing experiences and adopting institutional measures on a uniform basis, such that every country in the region can benefit from fair, transparent and equitable investment policies. Very importantly, there are also benefits in coordination of related environmental policies and regulations, so that those investments that are made in energy facilities in the future do not result in environmental problems but on the other side, work towards improving the existing quality of air, water and land resources.

2. Current Status of Energy Cooperation, Demand and Potential

2.1 *Current Status of Energy Cooperation*

Since Pakistan imported 16 MW of electricity from India's Jogindernager power station for a brief period after its independence[1], not much progress has been made. Recently, there has been talk of Pakistan exporting 1000-3000 MW of surplus hydel power to India by the fiscal year 1998-99[2]. Bangladesh and India have signed a pact to share their surplus power[3]. Surplus power in eastern states of India would be exported to electricity famine inflicted western region of Bangladesh, while surplus power from eastern parts of Bangladesh would be exported to north-eastern states of India[4]. Further, it has been agreed that the actual inter-tie points shall be selected by June 30, 1997, the initial period of cooperation would be five years and the Asian Development Bank shall fund the multi-million rupee project[5].

Prime Minister of India, Mr I K Gujral and his Nepalese counterpart, Mr Lokendra Bahadur Chand, signed a trade agreement on June 5, 1997 that allows power to be sold by interested parties in India and Nepal to either country and fixed a time-frame of six months for a detailed project report on the Mahakali River Basin treaty[6]. India has assisted Nepal in four hydro-electric schemes viz., Pokhara, Trisuli, Western Gandak and Devighat. Three major water resources projects in Nepal viz., Karnali, Pancheswar and Saptakoshi are under discussions. The exchange of power between India and Nepal is taking place at 17 points along Indo-Nepal border and the voltage level for new inter-connections has been agreed to be 132 KV to enable increased exchange of power. India has also agreed to provide 70 million units of energy to Nepal annually free of cost from Tanakpur hydro-electric project in India[7].

The Chukha hydro-electric project (336 MW) in Bhutan was implemented with Indian financial and technical assistance. The surplus power is being imported by India. Similarly, the Kurichu hydro-electric project (45 MW) in Eastern Bhutan is presently under implementation with assistance from India. An agreement has been signed between the two countries for the implementation of the Tala hydro-electric project (1020 MW), while consultations are underway for the Shankosh Multi-purpose Project (4060 MW)[8]. Additionally, India had constructed a number of Mini/Micro Hydel Schemes in Bhutan at Thimpu (360 KW), Gidakom (1000 KW), Wangdi (300 KW), Gyesta (1500 KW), Khaling (600 KW), Chenary (750 KW), Khalanzi (390 KW) and Lhuntshi (20 KW) during the period 1960-80[9].

[1] See Mujahida Naureen, *Pakistan Energy Resources* (Islamabad: National Institute of Pakistan Studies, Quaid-I-Asam University, 1994): 94-100

[2] The Times of India, Delhi (19 May 1997) and The Hindustan Times, Delhi (10 June 1997)

[3] The Indian Express, Delhi (6 June 1997)

[4] The Hindustan Times, Delhi (10 June 1997)

[5] The Times of India, Delhi (16 June 1997)

[6] The Indian Express, Delhi (6 June 1997)

[7] Annual Report, 1996-97, Ministry of Power, Government of India

[8] Annual Report, 1996-97, Ministry of Power, Government of India

[9] Annual Report, 1994-95, Ministry of Power, Government of India

No cooperation worth mentioning is taking place among the SAARC nations in the area of hydrocarbons or coal. Similarly, while there has been some talk for cooperation in areas of renewable energy sources such as solar thermal/photo-voltaics and small hydro-power (especially between Nepal and India), no substantial developments have taken place.

2.2 *Energy Demand in the SAARC Region*

The SAARC Region is characterised by the following : (i) rapid economic growth and industrial expansion (ii) high population growth and urbanisation (iii) substantial use of biomass forms of energy such as fuelwood, farm and animal waste, etc. (iv) increasing substitution of traditional or non-commercial fuels by commercial energy.

In 1996, Bangladesh, India and Pakistan were responsible for 3.5% of the total global consumption of primary commercial energy[10]. The use of primary energy in the countries of South Asia[11] grew at a rate of 5.8% per annum between 1971-93 (Table 3). Only the East Asian region and the Middle East countries had a faster rate of growth in energy consumption[12]. However, projections by the International Energy Agency for energy consumption up to the year 2010 forecast this region as having the highest growth rate in the world.

Table 1 : **Growth Rate of GDP (percent per annum)[2]**

Country	Growth Rate of Population[1] 1995-96 (% p.a.)	Base Year	1994	1995	1996	1997
Bangladesh	2.17	1985	4.2	4.1	3 6	5.5
Bhutan	3.1	1980	6.5	5.5	...	...
India	2.0	1980	6.3	6.2	6 4	6.6
Maldives	3.4	1985	6.6	6 8	...	..
Nepal	2.1	1975	7.3	2.3	5.6	5.2
Pakistan	2.8	1981	3.8	4.7	5.5	5.8
Sri Lanka	1.4	1982	5.6	5.6	5.2	5.5

Source [1] Study on Opportunities for Intra-Regional Investment Cooperation Amongst SAARC Countries.SAARC Chamber of Commerce. 1997
[2] Asian Development Outlook, 1996 and 1997, Asian Development Bank

Table 2 : **Income Elasticity**

Product / Country	Petrol	Diesel	LPG
Bangladesh	2.34	2.29	2.63
India	2.36	1.13	4.39
Pakistan	1.36	1.50	2.59

Source : The Demand for Oil Products in Developing Countries – D. Gately & S. S Streifel, World Bank Discussion Paper No 359

[10] BP Statistical Review of the World Energy 1997
[11] Bangladesh, India, Nepal, Pakistan & Sri Lanka
[12] World Energy Outlook, 1996 Edition, International Energy Agency

As Table 1 shows, the countries of the region are experiencing GDP growth rates of higher than 5% per annum. Taking the population growth into account, the per capita GDP growth rate still works out to be higher than 3% for these countries. Using income elasticity figures from Table 2, the demand in Bangladesh for Petrol, Diesel and LPG could experience a growth rate of over 7% per annum. In India, the demand for LPG could increase by a whopping 16% per annum, whereas for petrol about 8-9% and 4-5% for diesel. However, it must be noted that these calculations grossly underestimate the demand for diesel in India, which is projected by TERI to be anywhere between 10-15% in the coming years. Pakistan could experience a growth in demand for LPG of roughly 7%, and about 4% for diesel and petrol. Similar scenarios could be envisaged for other SAARC nations viz., Bhutan, Maldives, Nepal and Sri Lanka. With growth in per capita income, they too are bound to experience such high growth rates in demand for petrol, diesel and LPG. It must, however, be kept in mind that only the income elasticity figures have been used in creating this scenario. If future price rises are taken into account, it is bound to dampen the demand growth rate to a certain extent.

The projections by the International Energy Agency (Tables 3 & 4) are along similar lines. The key variables such as economic growth, energy prices, technological progress, government energy policy and the behaviour of energy consumers are treated to be independent of each other, with the understanding that though links exist among them, the links are too uncertain and ambiguous. The Capacity Constraints case combines baseline GDP and populations growth assumptions with rising energy prices and historical trends in energy efficiency. The Energy Savings case combines a higher energy efficiency with baseline economic growth and population growth assumptions, and flat energy prices. Consumption patterns may, however, alter significantly with increasing incomes and urbanisation; changing family structures; and relevant governmental policies.

Both the cases predict that by the year 2010, countries of South Asia shall be consuming more that double of current levels of primary commercial energy. Although the share of coal in the entire energy spectrum shall decline to about 41%, its net consumption shall continue to increase. Forecast to meet about 19% of the primary energy needs in 2010, a major increase both in quantum and in relative percentage, is seen for gas. The share of hydro-power shall roughly remain the same at about 3.5%. Little increase shall take place in the quantum of nuclear and renewable energy sources.

2.3 *Energy Potential Among the SAARC Countries*

In 1994, Pakistan produced only 2.77 mt of crude petroleum (R/P ratio = 10)[13] and consumed 14.5 mt, the balance being met by imports. While Bangladesh produces little quantities of crude petroleum (0.018 mt in 1994), other SAARC nations produce no noticeable quantity. India produced only 35 mt in 1996 and consumed 78.7 mt[14]. Oil consumption by Bangladesh and Pakistan in 1996 had risen to 2.4 mt and 17.1 mt respectively. Thus, as Table 5 also shows, consumption levels of liquid fuels far outstrip the production levels, leading to import of significant quantities of these fuels by all the SAARC nations. With demand far

[13] 1994 Energy Statistics Yearbook, United Nations
[14] BP Statistical Review of World Energy 1997

Table 3 : **Energy Demand - South Asia - Capacity Constraints Case**

	Levels				Growth Rates (% p.a.)				Fuel Shares (%)			
	1971	1993	2000	2010	1991-1993	1993-2000	2000-2010	1993-2010	1971	1993	2000	2010
PRIMARY ENERGY (MTOE)	72	251	355	658	5.8	5.0	6.4	5.8	100	100	100	100
Solids	39	129	153	270	5.6	2.5	5.8	4.5	53.5	51.2	43.2	41.1
Oil	27	82	128	233	5.2	6.5	6.2	6.3	37.6	32.7	36.0	35.4
Gas	3	31	57	125	10.7	9.4	8.1	8.7	4.5	12.2	16.2	19.1
Nuclear	0	2	4	5	7.2	12.5	3.3	7.0	0.5	0.6	1.0	0.8
Hydro	3	8	12	23	5.1	5.2	6.8	6.2	3.9	3.3	3.4	3.5
Geo/Others	0	0	1	1	-	8.2	5.0	6.2	0.0	0.0	0.2	0.2
Final Energy	55	162	245	461	5.1	6.1	6.5	6.3	100	100	100	100
Solids	25	44	58	93	2.7	4.0	4.7	4.4	45.5	27.4	23.8	20.1
Oil	23	72	112	207	5.4	6.5	6.3	6.4	41.5	44.6	45.8	44.9
Gas	2	18	31	74	10.5	8.3	9.1	8.8	3.6	10.8	12.5	16.0
Electricity	5	28	44	88	8.0	6.7	7.2	7.0	9.4	17.2	17.9	19.0
Power Generation net Input Other Transformation Net Input	17	89	110	196	7.7	3.0	6.0	4.8				
Electricity Output (TWh)	76	419	650	1241	8.1	6.5	6.7	6.6	100	100	100	100
Solids	32	250	363	710	9.8	5.5	6.9	6.3	42.5	59.8	55.9	57.2
Oil	6	26	43	65	7.3	7.3	4.3	5.5	7.3	6.2	6.6	5.2
Gas	4	40	90	178	10.9	12.5	7.0	9.2	5.4	9.5	13.9	14.3
Nuclear	1	6	14	19	7.2	12.5	3.3	7.0	1.7	1.4	2.1	1.5
Hydro	33	97	139	268	5.1	5.2	6.8	6.2	43.2	23.1	21.3	21.6
Geo/Others	0	0	1	1	...	46.7	5.0	20.5	0.0	0.0	0.1	0.1

Source : World Energy Outlook, 1996 Edition, International Energy Agency

Table 4 : **Energy Demand - South Asia - Energy Savings Case**

	Levels				Growth Rates (% p.a.)				Fuel Shares (%)			
	1971	1993	2000	2010	1991-1993	1993-2000	2000-2010	1993-2010	1971	1993	2000	2010
PRIMARY ENERGY (MTOE)	72	251	344	625	5.8	4.6	6.1	5.5	100	100	100	100
Solids	39	129	147	248	5.6	1.9	5.4	3.9	53.5	51.2	42.8	39.7
Oil	27	82	125	227	5.2	6.2	6.1	6 2	37.6	32.7	36.3	36.3
Gas	3	31	56	120	10.7	9.0	8.0	8.4	4.5	12.2	16.2	19.2
Nuclear	0	2	4	5	7.2	12.5	3.3	7.0	0.5	0.6	1.0	0.8
Hydro	3	8	12	23	5.1	5.2	6.8	6.2	3.9	3.3	3.5	3.7
Geo/Others	0	0	1	3	...	11.2	11.8	11.6	0.0	0.0	0.2	0.4
Final Energy	55	162	238	440	5.1	5.6	6.3	6.0	100	100	100	100
solids	25	44	56	83	2.7	3.2	4.1	3.7	45.5	27.4	23.3	18.9
Oil	23	72	110	202	5.4	6.1	6.3	6.2	41.5	44.6	46.2	46.1
Gas	2	18	30	71	10.5	7.8	9.0	8.5	3.6	10.8	12.5	16.1
Electricity	5	28	43	83	8.0	6.3	6.9	6.7	9.4	17 2	18 0	19.0
Power Generation net Input Other Transformation Net Input	17	89	106	186	7.7	2.6	5.7	4.4	...	...	...	...
Electricity Output (TWh)	76	419	634	1180	8.1	6 1	6.4	6 3	100	100	100	100
Solid	32	250	350	659	9 8	4.9	6 5	5.9	42.5	59 8	55.3	55.9
Oil	6	26	41	61	7 3	6 9	3 9	5 1	7.3	6.2	6.5	5.2
Gas	4	40	89	170	10.9	12.2	6 7	8.9	5.4	9.5	14.0	14.4
Nuclear	1	6	14	19	7.2	12.5	3.3	7.0	1 7	1 4	2 2	1.6
Hydro	33	97	139	268	5.1	5.2	6 8	6.2	43.2	23.1	21.9	22.7
Geo/Others	0	0	1	3	.	50.1	11.8	26.2	0.0	0.0	0.2	0.3

Source : World Energy Outlook, 1996 Edition, International Energy Agency

Table 5 : **Production, Trade and Consumption of Commercial Energy, 1994**
(Thousand Metric Tons of Oil Equivalent and kilograms per capita)

Country	Primary Energy Production					Imports	Exports	Consumption					
	Total	Solids	Liquids	Gas	Electricity			Per Capita	Total	Solids	Liquids	Gas	Electricity
Bangladesh	5755	...	113	5570	73	2171	0	62	7275	0	1633	5570	73
Bhutan	145	1	...	...	144	47	127	40	65	14	32	...	19
India	207566	152137	31992	15866	7572	47690	69	262	240592	159121	57907	15866	7699
Maldives	...	...	...	..	...	79	42	1603	31579	1378	17453	12271	478
Nepal	75	...	...	...	75	450	35	24	510	80	351	...	78
Pakistan	20151	1671	2823	13856	1800	12877	291	232	31742	2429	13657	13856	1800
Sri Lanka	352	...	...	...	352	2307	90	112	2033	2	1679	...	352

Source : 1994, Energy Statistics Yearbook, United Nations

outstretching supply, along with low R/P ratios, it means that all the SAARC nations shall continue to be net importers of crude petroleum, natural gas and various liquid fuels in the future.

As Table 3 shows, the consumption of gaseous fuels has increased at a rate of 10.7% per annum during the period 1971-93 and a nearly identical increase is projected till the year 2010. This means that, in the year 2010, this region shall be consuming over 3 times the current quantities of gaseous fuels. With Bangladesh, India and Pakistan having natural gas reserves of only 10.2 tcf[15] (R/P=38), 24.2 tcf (R/P=33.5) and 22.0 tcf (R/P=41) respectively at the end of 1996, the region shall need to import natural gas in large quantities to meet its demand. No SAARC nation is currently producing surplus natural gas for export to other nations.

With reserves of 69947 million tonnes (R/P ratio = 227) of coal, India is in a comfortable position. Pakistan possesses some reserves of coal and imports nearly 30% of its requirements. Other SAARC nations possess little or no quantity of coal.

Electricity demand is projected to grow at a rate of 6.7% per annum in South Asia during the period 1993-2010. Not only will the increase in income levels bring about higher consumption of electricity, but also electrification of areas yet not having access to electrical power shall cause a substantial increase in consumption.

As per the estimates by the Ministry of Power, India experienced a power shortage of 10.9% and a peak demand deficit of 16.9% during 1996-97. While power shortages are currently costing India 2% of its national income, it is estimated that India much have a generating capacity of 176647 MW in 2011-12 to meet the growth in peak demand for electricity[16], i.e. more than double its current capacity. Pakistan must increase its installed capacity to 54,000 MW by the year 2018 to meet its projected demand. The economic losses from electricity shortfalls, estimated at up to 2,000 MW during peak hours, cost it to the order of US $ 1 billion annually[17]. The Pakistan Power Minister, Mr Nisar Ali Khan, in April 1997, suggested a shift towards hydro-electricity due to environmental impacts caused by thermal power plants. However, a 5280 MW thermal power plant is already underway by the Hong Kong based Consolidated Electric Power Authority (CEPA) in Sindh. Among other initiatives, CEPA has also promised to explore and mine the coal deposits in the area[18]. Sri Lanka is facing chronic shortage of electric power and situation is expected to improve only partially in June 1997 when the 40 MW Sapugaskanda diesel power plant and 115 MW Kelanitissa gas turbine are expected to commence production[19].

Due to power cuts in Bangladesh, the industry lost 22% of working hours. Transmission lines do not have the capacity to transmit power from the power surplus east to the power deficit west. Situation in Bangladesh shall only improve by mid-1998 as bids for 3 barge mounted power plant of 100 MW each in Chittagong, Khulna and Narayanganz are received

[15] Trillion cubic feet
[16] Fifteenth Electric Power Survey of India, Central Electricity Authority, July 1995
[17] Aurangzeb Khan, Bilateral Cooperation in the Energy Sector, Regional Cooperation in South Asia : Prospects and Problems, February 1997, Occasional Paper No. 32, The Henry L Stimson Center, Washington, DC
[18] Economist Intelligence Unit, Pakistan and Afghanistan, 2nd Quarter 1997 : 15
[19] Economist Intelligence Unit, Sri Lanka, Country Report, 2nd Quarter 1997 : 21

and plants constructed. The 210 MW Rousan power plant is also expected to double its capacity till then with gas brought by Occidental Company from Sylhet. Similarly, Cairn Energy shall bring gas ashore from Sanghu gas field in Bay of Bengal[20]. Bangladesh also has plans to install 900-1000 MW of capacity with foreign assistance and 570 MW with private investment in the near future[21]. In Nepal, while energy consumption grew at a rate of 2.6% per annum during 1983-94, electricity consumption grew at a rate of 10.3% during the same period[22]. Medium hydro-electric projects currently under construction are 6.2 MW at Puwa Khola, 60 MW at Khimti Khola, 14 MW at Modi Khola and 20 MW at Chimlime.

Table 6 : **Power Scenario in SAARC Countries**

Country	Hydroelectric Potential[1] (MW)	Installed Hydroelectric Capacity[1] (MW)	Total Installed Capacity[2] (MW) 1995 Estimates	Future Projects [Capacity[2] additions (MW)] 1995-2000	Future Projects [Capacity[2] additions (MW)] 2000-2005
Bangladesh	52000	230	2908	1033	2042
Bhutan	21000	355	360	45	91
India	75400	21282[3]	84088[3]	52280[4]	45370[5]
Nepal	83000	254	296	116	286
Pakistan	20777	2892	12721	7000	3000
Sri Lanka	2000	1137	1387	640	432

Source : [1] Study on Opportunities for Intra-Regional Investment Cooperation Amongst SAARC Countries, SAARC Chamber of Commerce, 1997
: [2] SAARC Scan, February, 1997 (Used Energy Statistics, UN)
: [3] Dec. 1996 estimates (Annual Report, 1996-97, Ministry of Power, Government of India)
: [4] Estimate for 9th 5-Year Plan, Fourth National Power Plan 1997-2012, Central Electricity Authority
: [5] Estimate for 10th 5-Year Plan, Fourth National Power Plan 1997-2012, Central Electricity Authority

The share of hydro-electric in the South Asian region has been constantly falling from about 43% in 1971 to about 23% in 1993 and is projected to fall to about 19% in 2010 (Table 3). However, an enormous potential exists in the region for exploiting this source of power (Table 6). Bhutan and Nepal have enough potential to meet their present and future demands and yet export a large quantity of power to neighbouring countries. India has yet realised only a little more than one-fourth of its hydro-electric potential, Pakistan only about 15%, while Bangladesh has hardly realised it at all.

Thus, only surplus energy sources in the SAARC nations are coal in India, and hydro-electric power in Bhutan and Nepal. However, this does not mean that energy cooperation among the SAARC nations can take place in these areas only. The next chapter outlines that through innovative power sharing devices, pooling of resources and joint import agreements, the SAARC nations can create a win-win situation for themselves.

[20] Economist Intelligence Unit, Bangladesh, Country Report, 2nd Quarter 1997 : 24
[21] Economist Intelligence Unit, Bangladesh, Country Report, 1st Quarter 1997 : 25
[22] Economist Intelligence Unit, India and Nepal 1996-97. A Country Profile : 88

3. Opportunities for Cooperation

With all the SAARC nations facing chronic power shortages, combined with ever increasing usage of hydrocarbon fuels, it becomes imperative for them to develop a strategy to undertake joint action which results in benefits for all parties concerned. Not only do the policy makers face the dilemma of being able to meet the energy demands of the citizens, effective initiatives shall also be required to control and reverse the resultant degradation and depletion of the region's natural resources.

3.1 *Natural Gas*

Of the major sources of commercial energy in the world today, natural gas is considered to be one of the most environment-friendly – fewer emissions into the air and water, and minimal generation of solid wastes, when compared to coal or oil. Natural gas pipelines and gas-powered thermal power stations face little or no public opposition, unlike the situation for large hydro, nuclear power plants or coal-fired power stations. Given the constraints faced by India and Pakistan to develop their hydro-power potential or in nuclear power generation, natural gas could bridge the gap between the present coal and oil dependent supply systems, and the renewable energy sources that are expected to become commercially viable and provide much of the energy supply a few decades from now.

The use of natural gas as fuel has seen a meteoric rise in Bangladesh, India and Pakistan during the last 25 years and estimates show that demand in both India and Pakistan could be 8 billion cubic feet per day in each country by 2010, of which only about 25% could be supplied from domestically proven reserves[23]. Natural gas is an essential input for thermal-based power stations, as feedstock in the fertilizers and chemicals industry, and as an environment friendly and convenient cooking medium. Gas shortfalls are already being felt in India, Pakistan, western Bangladesh and Nepal.

India and Pakistan enjoy the proximity to two of the largest natural gas rich regions, viz., the Persian Gulf and Central Asia. Pakistan's immediate western neighbour, Iran, possesses the second largest gas reserves (only after the Russian Federation) which stood at 741.6 tcf at the end of 1996[24]. The Central Asian republic of Turkmenistan possesses natural gas reserves to the tune of 102 tcf. Natural gas supplied via pipeline from these countries is expected to cost about 35% less than LNG in Pakistan and Western or Northern India[25]. Given the quantum of natural gas required, this could result in substantial savings in the long term. With five of the seven SAARC nations, i.e. all except Sri Lanka and Maldives, in close proximity of each other and these reserves, possibilities of mutual cooperation become multifold.

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[23] Raza, Hilal and Y. R. Mehta (1995) Papers presented at the Workshop *on Enhancing Regional Cooperation in South Asia through Collaboration in Energy and Environment*, held at Singapore from 2-4 December, 1995. Sponsored by the United Nations Development Programme.

[24] BP Statistical Review of the World Energy 1997

[25] Siddiqi, Toufiq A. (1996) South Asian Cooperation for Enhancing Energy Supply in the 21st Century. Asia Energy Vision 2020 : Sustainable Energy Supply, World Energy Council & The Institution of Engineers (India), Pg. 211-223.

3.11 *Iran Option*

This would consist of a 3000 km long pipeline originating near the Iranian port city of Assaluya in Southern Iran, proceeding on-shore eastwards to the city of Karachi, Pakistan and further eastwards to the state of Gujarat, India. The gas in India could then be further be supplied to Nepal for power generation and household cooking. The pipeline would have an initial transmission capacity of 3.2 bcf (billion cubic feet) a day (1.6 bcf each for India and Pakistan) and an ultimate capacity of 7 bcf a day (3 bcf for Pakistan, 4 bcf for India). The project would cost about US $ 4-5 billion. The supply from this pipeline would meet roughly half the gas demand projected for the year 2010. The French major Total SA has already decided on a US $ 3.5 billion package to develop the South Pars gas reserve in Iran[26], which could then supply gas through this pipeline.

A hindrance is the threat of US sanctions against companies doing business with Iran. While Total SA has already decided to develop the gas field, a pipeline would have to be constructed and maintained in Iran. Mechanisms would have to be developed to either bypass these US sanctions or pay the price for violating them.

3.12 *Turkmenistan Option*

Turkmenistan has substantial amount of gas reserves in the Daulatabad area, close to the border of Afghanistan and Iran. The US company, Unocal, in a consortium with the Saudi company, Delta, is already proposing a 1270 km gas pipeline from there to the Pakistani city of Multan[27]. The main hitch is the current hostilities in Afghanistan, through which this pipeline must pass on its way.

If potential/facilities for purchase of substantial quantities is shown in India, and there are already talks about it, this could very well act as a joint pipeline for both India and Pakistan. Only the diameter of the proposed pipeline would need to be increased and its extension to India facilitated. Since this would be completely under the international private sector, chances are very slim that Pakistan would be able to disrupt the supplies to India at any point of time.

With Unocal having already shown interest in laying down the pipeline, a substantial part of the costs involved shall be either borne or arranged by them. The rest could come from the sources outlined later in this chapter.

If both these gas pipeline options are exercised, they would ensure sufficient gas supply to the South Asian region to meet its entire demand for the next 12-15 years.

[26] The Economic Times, New Delhi (20 May 1997)
[27] The Hindustan Times, New Delhi (19 May 1997)

3.13 *Addressing the Concerns*

Sufficient technical expertise exists within India to lay down on-shore pipelines. An on-shore pipeline would be easy to maintain and service in the event of ruptures, leakages or corrosion. In building a single joint pipeline for India and Pakistan, most of the items of expense between Iran/Turkmenistan to Pakistan will not substantially impact the project cost. Such items and project activities include preliminary design to detail design, acquiring the right of way, pipe laying, specifications of pipes (except for diameter increase), associated valves, fittings, pipeline coating and project management. Thus a single pipeline would result in savings in pipeline material up to 50% of the material needed to construct two independent pipelines.

A serious impediment is the current political distrust between India and Pakistan. India fears that Pakistan could use the pipeline as a strategic tool in the event of a future conflict, leading to severance or disruption of gas supplies to India. The following are the measures which could render the single pipeline scheme free from such crisis and deter Pakistan from tampering with the pipeline in a manner detrimental to India's interests.

- Iran/Turkmenistan should give a commitment to immediately halt gas supplies to Pakistan in the event it decides to disrupt/sever gas supplies to India. Thus, Pakistan would stand to jeopardise its own supply in case it acted in the manner noted above.

- Insurance by Multilateral Investment Guarantee Agency (MIGA), a World Bank affiliate, or an international firm to cover losses accruing to India in the event of Pakistan acting in a manner detrimental to India's interests. The cost of the premium would be borne by both the nations equally.

- Private sector should play the leading role, with governments just facilitating the policy framework enabling the setting up of the pipeline in the earliest technically-possible time frame. The companies involved would be from both the nations and multinationals, thereby spreading the stake. Any disruption/severance of gas supplies to India would affect their profitability and the credibility of the Pakistan's government in the eyes of the private investor. These companies would also have a stake in other critical projects in both India and Pakistan, thus being able to apply pressure for Pakistan not to act in a manner detrimental to India's interests.

- India could use the gas to generate power and sell it to Pakistan. Any disruption in gas supplies would lead to disruption of power supply to Pakistan.

- As the projects would involve more than one nation, the World Bank and the Asian Development Bank are very likely to show keen interest in funding these massive pipelines. They could also have an equity stake initially, to be divested after a period of 10-12 years, to put pressure on Pakistan to honour its commitments to India regarding the gas supply.

3.14 *Financing Options*

Once the economic, technical and political viability of these projects is established beyond doubt in the minds of the potential investors or financiers, finance for these projects would pose no major problems. It would take the form of debt, equity, suppliers' credit and other sources.

The debt sources consist of international commercial banks, government agencies, and multilateral agencies such as the World Bank, International Finance Corporation, European Bank (EBRD), Asian Development Bank and IDB. Bilateral agencies and Export Credit Agencies (ECAs) can provide funding on a smaller scale. Equity sources are project sponsors, including international oil/gas companies. The other sources are leasing and foreign aid, though their magnitude is relatively small. Bonds, to be encashed at a later date, or shares (equity) could be sold to the general public and to Foreign Institutional Investors (FIIs) that pay back based on handsome returns generated by these projects.

A list of external funding sources[28] is given below for various stages of the project:-

Feasibility & Promotion	Multilateral Lenders Aid Agencies
Design, Construction & Completion	International Oil/Gas Companies Multilateral Lenders Export Credit Agencies Commercial Lenders Construction Contractors Industrial Firms
Rehabilitation	Multilateral Lenders Export Credit Agencies International Oil/Gas Companies

3.15 *Joint Bangladesh-India Pipeline*

While eastern Bangladesh is gas rich, its western region lacks sufficient energy supplies. Similarly, the Indian state of Tripura has extensive gas reserves, while the states of West Bengal, Bihar and Orissa could use supply from these reserves to their benefit. .

A joint pipeline is proposed to originate from Tripura in North-Eastern India, passing through East Bangladesh where it joins the existing gas pipeline (drawing from or delivering gas to it) and make its way through Western Bangladesh to the Indian state of West Bengal. For India,

[28] David Moore, "Financing Options for Gas Infrastructure Development", (1995). Paper presented at the Natural Gas Potential : South Asia Summit, organised by the Asian Development Bank in New Delhi from 19-21 March, 1995.

this could mean a very short and cheap route to supply the surplus gas in Tripura to the eastern states. Bangladesh could benefit by enabling and ensuring supply of sufficient surplus gas from its eastern region to the energy starved western region.

The initiative and onus could be given to the private sector to set up this pipeline, which would impose no major technical problems. A fee structure based on usage as well as a minimum guaranteed payment could be worked out so as the costs are borne fairly by the users.

3.16 *Gas from India to Nepal*

While Nepal has a massive hydro-electric potential, an estimate shows that power generated by natural gas would cost about Nepalese Rupees 3.5 per Kwh as compared to Nepalese Rupees 4.75 per Kwh for hydropower[29]. Further, with the city of Kathmandu is facing severe air quality problems, use of LPG for household cooking would ameliorate the situation. If India is able to source natural gas from Iran/Turkmenistan, Nepal could avail of this gas at a very competitive price. Indian companies could provide Nepal organisational skills in managing efficiently a cylinder-based LPG/LNG delivery system, which would be very apt for Nepal, given its far-flung population and hilly tracts.

3.2 *Power*

As was noted earlier, Bangladesh and India are electricity deficient countries. With Bhutan and Nepal possessing hydro-electric potentials of 21000 MW and 83000 MW respectively, and the likelihood that their domestic consumption levels shall not approach such levels in the foreseeable future, these potentials could be utilised for exports resulting in precious foreign exchange earnings for them. This position has been endorsed by both the governments too. Since both these nations do not possess the resources, technology and organisational skills to realise the hydel potential on such a vast scale, it calls for other nations such as India and Bangladesh to provide these inputs and be the beneficiaries by importing this power. This shall also provide Bhutan and Nepal with adequate money for their development plans.

Involvement of Bangladesh shall not only bring about enhanced cooperation in the area of power among the SAARC nations, it shall further cement relations and lead to a sense of greater trust among the four nations, viz. Bangladesh, Bhutan, India and Nepal. Further, as River Ganges passes through Bangladesh, it is bound to have an interest in the development of upstream tributaries of the Ganges. With four developing countries involved in these hydro-electric projects, it shall attract substantial commitment from the World Bank, the Asian Development Bank and other multilateral agencies.

[29] Sharma, Shanker P. (1996) "Prospect for Natural Gas Utilization in Nepal" presented at the Workshop *on Enhancing Energy and Environment Cooperation in South Asia*, held at Islamabad, 27-28 March, 1996.

3.21 *Benefits*[30]

Cost Efficiency : Over the medium to long term, hydropower is a considerably cheaper source of electricity than thermal power. While hydropower involves no fuel costs and little operation & maintenance costs, massive strain is put on the infrastructure by thermal plants in terms of rail/road transport of fuel, disposal of ash, development of coal/oil/gas fields and utilisation of port facilities.

Water Resource Management : Hydropower schemes provide three additional benefits, of great relevance to the South Asian countries, i.e. irrigation, waterways and flood mitigation. Due to monsoon based seasonal rainfall, while floods occur during the rainy season, substantial areas suffer for want of water during the summer. Storage of water in reservoirs shall allow for regulated use of water the year round, while mitigating the flood scenario during the monsoon season.

3.22 *Nepal Option*

On the basis of different studies, Nepal has identified 99 hydro-electric projects with a total generating capacity of about 28700 MW while the energy generation potential exceeds 136,000 Gwh per annum[31].

Table 7 : **Identified Hydro-electric Potenial in Nepal**

River Basin	No. of Projects	Generating Capacity (MW)	Firm Energy (GWh)
Karnali	27	10474.4	29588
Mahakali	4	2279.5	10085
Gandaki	12	4900.0	20398
Southern	4	100.0	...
Kosi	52	10949.4	...

Source : *Emerging Resources Base of Nepal, Perspectives Energy Plan*, Water and Energy Commission Secretariat, Kathmandu, 1995

For hydro-electric projects of a capacity less than 1000 MW, the Nepalese government has done away with licensing requirements and shall impose no royalty or tax on them. Additionally for all hydro-electricity projects, the export of electricity shall be allowed and commercial loans made available by financial institutions. Foreign or national equity of up to 100% has been allowed for the development of hydro-electricity.

[30] Aurangzeb Khan, Bilateral Cooperation in the Energy Sector, Regional Cooperation in South Asia : Prospects and Problems, February 1997, Occasional Paper No. 32, The Henry L Stimson Center, Washington, DC

[31] Study on Opportunities for Intra-Regional Investment Cooperation Amongst SAARC Countries. (1997). SAARC Chamber of Commerce and Industry: Pg. 168

Hydro-power from Nepal awards the following benefits for India[32]:

- Capital costs for the 6400 MW Pancheshwar hydro-electric project are estimated to be only INR 2 to 2.5 crore per MW.
- It shall meet the much-needed peaking energy to back up the thermal generation especially in the northern and eastern regions.
- Rather than being out and out commercial ventures, the hydro-power projects in Nepal would be jointly developed by India and Nepal.

As mentioned earlier, India has already initiated the process of assisting Nepal in the execution of hydro-electric projects. From the private sector, the Tata Group and Enron have shown interest in setting up such units. However, acceleration of the utilisation of the vast hydro-electric potentials of Nepal needs to take place. A set of policy, institutional and fiscal measures would be required for this purpose.

Hydro electric projects require a longer time frame than thermal plants to become functional. A larger set of governmental clearances, rehabilitation of large populations and the fear of reprisal from environmental organisations deter private participation in these projects. History has shown that the government changes more than once over the period of execution of the project. The new government may order a fresh set of clearances to be required or may order to stop work on the project completely. This proverbial "Sword of Damocles" acts as a serious impediment to private initiatives.

While a single window facility would be helpful, decision making by the government within a limited time frame would be very welcome. Provision could be made that once all required clearances are obtained, the government shall not have the right to revoke them or order a set of new ones. An independent tribunal could be set up to take care of any serious concerns which may arise at a later date. Of course, it would be in the interest of the promoters to work together with the widest possible audience before, while and after executing the project. Strong coordination would be required with the Power Grid Corporation of India and corresponding bodies in Nepal, Bhutan and Bangladesh to ensure delivery of power to the required points.

3.23 *Bhutan Option*

While Bhutan has not opened its doors to the private sector for the development of the hydro-electric power projects, as mentioned earlier, it has sought and received substantial technical and financial assistance from India to harness its potential. The same process could be accelerated with the involvement of Bangladesh so as to attract more resources – financial, technical and a stronger Bhutanese government commitment. Bhutan too stands to gain substantially as the past experience with respect to the projects implemented earlier with Indian assistance shows. With the export of electricity to India from the 336 Chukha hydro-electric project, Bhutan earned the entire cost of the project in about five years time alone, besides their internal consumption of electricity. This example alone should be enough to showcase the strong financial feasibility of hydro electric power projects.

[32] The Hindustan Times, Delhi (24 June 1997)

3.24 *India-Pakistan Cooperation*

India could generate power at coal pitheads using its substantial reserves of coal. Estimates at TERI have shown that the cost of generation would be about INR 1.50 per Kwh. The transmission from there to Pakistan could take place using 2 HVDC lines of 3000 MW each, at ± 500 kV. In the event of outage, about 3500-4000 MW could still be transmitted. Assuming a distance of 2000 km, a loss of 5% during transmission, transmission for 8000 hours a year (1 year = 8760 hours), an interest rate of 15% on the capital and a life span of 30 years of the transmission lines, the cost of transmission comes out to be about INR 0.27 per Kwh. Therefore, the total cost of electricity generation and transmission to Pakistan turns out to be INR 1.77 or less than US 5¢ per Kwh. The Government of Pakistan has already declared its intent to purchase power at US 6¢ per Kwh from the private power producers. Power producers in India could thus compete effectively with producers in Pakistan and provide power at competitive rates to Pakistan.

3.3 *Petroleum*

3.31 *Refining*

As on 1 May 1996, the refining capacity of India stood at 60.40 million tonnes per annum. With the proposed expansions and grassroots projects, the same is expected to exceed 100 million tonnes per annum by the year 2000[33]. On the average, the Indian refineries have performed very efficiently with the throughput nearly equaling or exceeding the refining capacity. With the South Asian region poised to consume 128 million tonnes of oil in the year 2000, a substantial amount of refining capacity shall be required in this region to meet the demand for various liquid fuels.

Given the low consumption levels of petroleum products by Bangladesh, Pakistan and Sri Lanka as compared to India, it could take the lead and initiate refining of crude petroleum for them. This would lead to economies of scale at the point of purchase and at the time of refining, thus resulting in cheaper fuels for all. Bangladesh could import these products from the 9-million tonne refinery being set up at Paradeep on the eastern coast. A 12-million tonne refinery could be set up in the Indian state of Punjab, which could supply products to northern Pakistan and India simultaneously. Similarly, Sri Lanka could source some of its needs from the refineries at Madras and Narimanam on the south-eastern coast of India. The region could take a common leap to usage of unleaded petrol and low sulphur diesel oils. Air pollution is of great concern in most cities of the region and such an initiative would help them meet environmental standards.

[33] TERI Energy and Data Directory Yearbook, 1996-97 : 57

3.32 *Exploration*

The geological structures are similar in the Sind Province of Pakistan and in Rajasthan, India. Sharing of seismic data, insight and other information between the two nations could be of tremendous help not only in being more successful in exploring oil/gas but also doing it more effectively and efficiently. Similarly, the structures in eastern Bangladesh and north-eastern India are similar and rich in oil and gas. Sharing of data/information for these regions could bring about spectacular results for both the countries.

3.4 *Coal*

With vast reserves of coal, India could export them in large quantities. While largely the Indian coal has high ash content, it has the advantage of having low sulphur content. Bangladesh could import all its coal requirements from the Raniganj coal fields in India, which has large quantities of superior grade coal available. The entire transport would be by rail, making it very cheap for Bangladesh.

3.5 *Renewable Energy*

A large part of the population of each SAARC country lives in remote areas where the easy reach of conventional grid electricity and hydrocarbon fuels is quite uncommon. The infrastructure costs involved in providing them with access to such forms of energy is staggering and beyond the reach of the governments, while making the process of conventional electrification uneconomical. However, the governments and societies in general in South Asia are dedicated to the cause of poverty removal and giving the advantages of modern technology to the large masses of poor people in the region. At the same time, a need is felt to mitigate the environmental impacts brought about by such higher per capita energy usage in the models followed so far as these impacts are ultimately very harmful to human health and overall economic welfare.

The renewable energy sources such as the sun and the wind could be utilised to meet the above mentioned objectives while meeting the environmental stipulations. They have the advantage of being installed at the point of consumption, thus obviating the need for expensive grid network and doing away with the accompanying transmission losses. At the same time, they cause little stress on the environment.

3.51 *Solar Photo-voltaic*

Economies of scale would benefit the countries of the region if common projects for solar photo-voltaic power generation would be identified for meeting the energy demands of more than one country. The benefit of scale also carries with it significant technological advantages. It has been calculated that in the manufacture of photo-voltaic cells, the photo-voltaic modules of one watt capacity cost between US $ 1.2 to 2.7 in a facility that produced 100,000 m^2 of 10% efficient array per year. These costs could be brought down to US $ 0.5 to 0.8 for the same capacity module in a facility producing 1 million m^2 per year of 15%

efficiency modules. SAARC represents a potentially vast market for photo-voltaic devices, but the benefits of market size can only be achieved if production takes place on a large enough scale. There is, therefore, considerable economic and technological merit in the establishment of joint ventures that could produce large quantities for supplying all of SAARC region as well as other countries in the region at costs that could be much lower than those applicable to other manufacturing locations.

3.52 *Wind Energy*

India has a total wind power installed capacity of 820 MW – mostly in Tamil Nadu, Gujarat and Andhra Pradesh – making it among the top three countries in harnessing this renewable source of energy. It also has the largest wind resource assessment effort, undertaken since 1985. Thus, India could provide technical expertise in the identification of potential wind energy generation sites and installation of wind energy generators to other SAARC countries. Pakistan could gain from the Indian experience by exploiting the wind power in Sindh province, whose wind regimes would be very similar to those in Gujarat. Maldives, given its location in the middle of the Indian Ocean, is bound to have high velocities of wind hitting its coastline and given its well-spread out population, could especially benefit from cooperation in this area.

3.53 *Micro Hydro-Power*

Nepal has been building equipment for small scale hydro power for several years, and has acquired considerable experience in this area. Many of the potential sites for small hydro in the other six SAARC nations have similar characteristics and the Nepalese experience could be utilised there.

4. Economic Benefits of Cooperation

4.1 *Benefits*

Some of the direct benefits accruing to the economies of the SAARC countries due to cooperation in the above mentioned areas are given below:-

- By sharing of seismic data/information between India and Pakistan, and, between Bangladesh and India, the exploration costs and time could be significantly reduced for each country. Further, enhanced production of oil/gas brought about by this cooperation would reduce the dependence on imports and save precious foreign exchange.

- A common gas pipeline for India and Pakistan would significantly reduce costs of delivery for both the countries, resulting in savings to the tune of millions of dollars annually. Since expertise for laying down the line exists in India, it would be considerably cheaper to lay it indigenously than inviting foreign firms to undertake this task.

- A joint production facility for solar film modules would drastically reduce the costs of production, resulting in cheaper power for the remote areas of the SAARC countries.

- Cost of importing coal from India for Bangladesh would be very cheap as the coalfields are situated near western Bangladesh (which is energy deficient) and the entire transportation could take place by rail. Further, the Indian coal has low sulphur content, thus being less harmful to the environment.

- Introduction of more environment-friendly fuels such as natural gas, hydel power, solar energy and wind power shall result in reduced emissions of suspended particulate matter into the atmosphere, along with reduced emissions of sulphur and nitrogen oxides. This shall lead to lesser incidences of diseases caused by such pollution, resulting in reduced health care costs. Abatement of pollution by energy consumption shall be an important step towards realising the goal of sustainable development in the SAARC region.

- Studies by TERI have shown that 2.2 million premature deaths are caused annually in India due to indoor air pollution, mostly brought about by usage of biomass fuels such as wood, dung, etc. This problem is common to all SAARC nations. A switch to kerosene for all such households in Delhi alone could result in net economic gains of US $ 8 million annually. The situation would be better if the switch is to LPG/LNG. These switches would be accelerated by cooperation to enhance indigenous production of oil/gas, as well as sourcing gas cheaply from Iran/Turkmenistan. If sufficient electricity is made available, this clean power could well replace biomass, oil and gas fuels in the households.

- As mentioned earlier, energy and power shortages have resulted in lost production for the industries of SAARC countries. With cooperation among each other, these shortages could become a thing of the past, raising industrial productivity to higher limits. This shall also make the businesses of the region more competitive in the international market.

- At the regional level, the availability of energy, particularly electricity, in areas that formerly did not have it, would lead to additional economic activity and job creation coupled with higher productivity in areas that have usually been the poorest ones in these countries.

- A common thrust to the usage of unleaded petrol and low-sulphur diesel shall bring about considerable benefits to the environment – local, regional and global. The deleterious effects of lead, especially on children, and of the transboundary phenomenon of acid rain caused by sulphur oxides are well known. Moreover, usage of unleaded petrol results in the ability to use catalytic converter technology in vehicle exhausts, reducing air pollution even further.

4.2 *Employment Generation and Skill Exchange*

Implementation of these joint efforts shall bring about investment to the tune of tens of billions of dollars. This shall generate considerable employment – blue collared, white collared and unskilled. Further, forward and backward linkages shall provide a boost to the related sectors such as cement, steel, heavy machinery, packaging and petrochemicals. Services areas such as engineering and industrial designing, finance and leasing shall receive a boost. Employment shall be substantially increased in these sectors too.

Implementation of various projects shall enhance the level of skills – technical, professional and managerial. India has an extensive wind energy generation programme and could impart the associated knowledge, skills and experience to the other SAARC nations. The same is true for utilisation of solar thermal and photo-voltaic energies. In the field of LPG/LNG, India could provide substantial help in terms of technology and systems knowledge about bottling, handling and distribution of the same for household use. With both the public and the private sectors in India equipped to handle laying down of oil/gas pipelines over long distances, this expertise could be made use of by Pakistan and Bangladesh while establishing joint pipelines.

Cooperation in the area of energy would result in building confidence among various nations and provide the basis for more economic and commercial activities – increased trade, travel and tourism, and cultural exchange.